

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings of claims in the application:

LISTING OF CLAIMS:

Claims 1-54 (cancelled)

55. (new) A method for producing carbon nanotubes from a gas phase, characterised in that the method comprises the following steps:

producing catalyst particles by physical vapor nucleation of catalyst material or by solution droplet thermal decomposition of catalyst precursor or by aerosolization from a powder or suspension ; and

using said catalyst particles and one or more carbon sources in a reactor to produce carbon nanotubes.

56. (new) A method according to claim 55, characterised in that the catalyst precursor and/or the catalyst material contains one or more metals.

57. (new) A method according to claim 55, characterised in that the catalyst particles are formed due to the nucleation of supersaturated vapor wherein the vapor is evaporation from one or more resistively heated wires consisting of one or more metals or metal alloys, due to metal or alloy laser ablation, due to metal or alloy arc, spark or electrostatic discharge, due to evaporation from a conductively heated metal or alloy or due to evaporation from radiatively heated metal or alloy.

58. (new) A method according to claim 57, characterised in that the supersaturation is created by means of gas cooling by convective, conductive and/or radiative heat transfer and/or adiabatic expansion.

59. (new) A method according to claim 55, characterised in that the catalyst particles are produced before the synthesis of carbon nanotubes in the reactor.

60. (new) A method according to claim 55, characterised in that the catalyst particles are classified according to one or more particle properties.

61. (new) A method according to claim 60, characterised in that the catalyst particles are mobility-size classified, mass classified, solubility classified, reactivity classified, inertially classified, thermophoretically classified, diffusional classified, charge classified, crystallinity classified and/or gravitationally classified.

62. (new) A method according to claim 60, characterised in that the catalyst particles are classified by a differential mobility analyzer or by a mass spectrometer.

63. (new) A method according to claim 55, characterised in that the carbon source comprises a hydrocarbon.

64. (new) A method according to claim 55, characterised in that the carbon source comprises methane, ethane, propane, acetylene, ethylene, benzene, toluene, o-xylene, p-xylene, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, C<sub>15</sub>H<sub>32</sub>, C<sub>16</sub>H<sub>34</sub>, C<sub>17</sub>H<sub>36</sub>, C<sub>18</sub>H<sub>38</sub>, methanol, ethanol, propanol, butanol, pentanol, hexanol, heptanol, octanol, acetone, methyl ethyl ketone, formic acid, acetic acid and/or carbon monoxide.

65. (new) A method according to claim 55, characterised in that the method further comprises using one or more reagents.

66. (new) A method according to claim 66, characterised in that the reagent(s) is/are used for

participation in a chemical reaction with one or more catalyst particle precursors and/or with one or more catalyst particles and/or with one or more carbon sources and/or with amorphous carbon deposited on carbon nanotubes and/or with carbon nanotubes.

67. (new) A method according to claim 65, characterised in that the chemical reaction of the reagent(s) with catalyst particle precursor and/or with pre-made particles is/are used for promotion of carbon nanotube formation and/or in that the chemical reaction of reagent(s) with amorphous carbon is/are used for carbon nanotube purification and/or in that the chemical reaction of reagent(s) with the carbon nanotubes is/are used for carbon nanotube functionalization and/or carbon nanotube doping.

68. (new) A method according to claim 65, characterised in that the reagent is an alcohol, H<sub>2</sub>, H<sub>2</sub>O, NO, CO<sub>2</sub>, PH<sub>3</sub> and/or NH<sub>3</sub>.

69. (new) A method according to claim 55, characterised in that the method further comprises the following step:  
using one or more additives to produce a composite carbon nanotube formulation.

70. (new) A method according to claim 55, characterised in that the residence time, temperature and/or catalyst particle properties and/or catalyst particle concentration and/or reagent concentration and/or carbon source concentration histories in one or more reactors are controlled.

71. (new) A method according to claim 55, characterised in that there are two or more existing catalyst particle supplies which are composed of particles of essentially similar sizes, compositions, concentrations, states and/or morphologies or are composed of two or more

distinct sizes, compositions, concentrations, states and/or morphologies.

72. (new) An apparatus for producing carbon nanotubes from a gas phase, characterised in that the apparatus comprises:

means for producing catalyst particles by physical vapor nucleation of catalyst material or by solution droplet thermal decomposition of catalyst precursor or by aerosolization from a powder or suspension; and  
one or more reactors for producing carbon nanotubes using said catalyst particles and one or more carbon sources.

73. (new) An apparatus according to claim 72, characterised in that said means for producing catalyst particles comprises one or more pre-reactors.

74. (new) An apparatus according to claim 72, characterised in that said means for producing catalyst particles comprises a hot wire generator.

75. (new) An apparatus according to claim 72, characterised in that the apparatus further comprises one or more of the following:

one or more catalyst particle classifiers;  
one or more carbon nanotube samplers;  
one or more carbon nanotube classifiers;  
one or more sources supplying energy to said means for producing catalyst particles and/or to said reactor;  
one or more means for introducing one or more reagents and/or additives to the means for producing catalyst particles and/or to the reactor;  
one or more aerosol samplers and/or classifiers extracting all or part of the carbon nanotube aerosol flow;  
one or more aerosol samplers and/or classifiers extracting all or part of a composite carbon nanotube aerosol flow.

76. (new) An apparatus according to claim 72, characterised in that the surface of the reactor and/or the means for producing catalyst particles contain material included in one or more catalyst particles or in that the surfaces of the reactor and/or the means for producing catalyst particles are saturated with material included in one or more catalyst particles.

77. (new) An apparatus according to claim 72, characterised in that there are two or more pre-reactors and said pre-reactors are operated in parallel and said parallel pre-reactors are operated at essentially similar conditions and/or with essentially similar materials so as to produce catalyst particles of essentially similar sizes, compositions, concentrations, states and/or morphologies or said parallel pre-reactors are operated at different conditions and/or with different materials and/or methods so as to produce catalyst particles of two or more distinct sizes, compositions, concentrations, states and/or morphologies.

78. (new) An apparatus according to claim 72, characterised in that said reactors are operated in parallel and said parallel reactors are operated at essentially similar conditions and/or with essentially similar materials so as to produce carbon nanotubes with essentially similar length, diameter, morphology and/or chirality or said parallel reactors are operated at different conditions and/or with different materials and/or methods so as to produce carbon nanotubes with two or more distinct lengths, diameters, morphologies and/or chiralities.

79. (new) An apparatus according to claim 72, characterised in that the reactor length, volume and/or wall temperature and/or the flow rate of carbon sources and/or reagents and/or carrier gases are used to control the residence time and/or temperature history of catalyst

particles and/or carbon nanotubes and/or composite carbon nanotubes in the reactor(s) and/or pre-reactor(s).

80. (new) Carbon nanotubes produced with the method according to claim 55.

81. (new) Carbon nanotubes according to claim 80, characterised in that the length, diameter, number of walls, chirality, purity, and/or composition of dopants and/or attached functional groups are controlled.

82. (new) Carbon nanotubes according to claim 80, characterised in that the attached functional groups are fullerenes, carbon nanotubes, transition metals, transmission metal oxides, polymers and/or polymer catalysts.

83. (new) Carbon nanotubes according to claim 80, characterised in that the carbon nanotubes are coated with one or more additive solids or liquids and/or solid or liquid particles to constitute a carbon nanotube composite.

84. (new) Carbon nanotubes according to claim 83, characterised in that the coating material is a metal, a polymer, an organic, a ceramic or a mixture thereof.

85. (new) Carbon nanotubes according to claim 80, characterised in that the carbon nanotubes and/or composite carbon nanotubes are formulated as a dispersion in a gas, a dispersion in a liquid, a dispersion in a solid, a powder, a paste or a colloidal suspension or are deposited on a surface.

86. (new) A functional material, characterised in that it is made using carbon nanotubes according to claim 80.

87. (new) A thick or thin film, a line, a wire or a layered structure, characterised in that it is composed of a functional material according to claim 86.

88. (new) A thin or thick film, a line, a wire or a structure according to claim 87, characterised in that it is deposited by electrical, acoustic, thermophoretic,

inertial, diffusional, turbophoretic and/or gravitational forces.

89. (new) A thin or thick film, a line, a wire or a structure according to claim 87, characterised in that the deposition is enhanced by jet focusing.

90. (new) A device, characterised in that it is made using carbon nanotubes according to any of claims 26 - 31 and/or a functional material according to claim 82.

91. (new) A device according to claim 90, characterised in that the device is an electrode of a fuel cell or battery, a heat sink or heat spreader, a metal-matrix composite or polymer-matrix composite in a printed circuit or electron emitter in a field emission display.